



BMJ Open Are there ethnic and religious variations in uptake of bowel cancer screening? A retrospective cohort study among 1.7 million people in Scotland

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ABSTRACT

Objective Cancer screening should be equitably accessed by all populations. Uptake of colorectal cancer screening was examined using the Scottish Health and Ethnicity Linkage Study that links the Scottish Census 2001 to health data by individual-level self-reported ethnicity and religion.

Setting Data on 1.7 million individuals in two rounds of the Scottish Bowel Cancer Screening Programme (2007–2013) were linked to the 2001 Census using the Scottish Community Health Index number.

Main outcome measure Uptake of colorectal cancer screening, reported as age-adjusted risk ratios (RRs) by ethnic group and religion were calculated for men and women with 95% CI.

Results In the first, incidence screening round, compared with white Scottish men, Other White British (RR 109.6, 95% CI 108.8 to 110.3) and Chinese (107.2, 95% CI 102.8 to 111.8) men had higher uptake. In contrast, men of all South Asian groups had lower uptake (Indian RR 80.5, 95% CI 76.1 to 85.1; Pakistani RR 65.9, 95% CI 62.7 to 69.3; Bangladeshi RR 76.6, 95% CI 63.9 to 91.9; Other South Asian RR 88.6, 95% CI 81.8 to 96.1). Comparable patterns were seen among women in all ethnic groups, for example, Pakistani (RR 55.5, 95% CI 52.5 to 58.8). Variation in uptake was also observed by religion, with lower rates among Hindu (RR (95%CI): 78.4 (71.8 to 85.6)), Muslim (69.5 (66.7 to 72.3)) and Sikh (73.4 (67.1 to 80.3)) men compared with the reference population (Church of Scotland), with similar variation among women: lower rates were also seen among those who reported being Jewish, Roman Catholic or with no religion.

Conclusions There are important variations in uptake of bowel cancer screening by ethnic group and religion in Scotland, for both sexes, that require further research and targeted interventions.

BACKGROUND

Bowel cancer is the third most commonly diagnosed cancer in both men and women in Scotland.¹ Bowel cancer screening using the faecal occult blood test (FOBT) was started across all National Health Service (NHS)

Strengths and limitations of this study

- The most fine-grained analyses of bowel screening uptake by ethnicity reported to date, using a nationally tested classification of ethnic groups.
- The study benefits from high overall linkage rates of census and National Health Service Community Health Index numbers, with a large national population, and a high linkage rate with Bowel Screening data.
- The small numbers of outcomes for some non-white populations has required aggregation of data for some ethnic groups, restricting reporting of invasive cancer for some ethnic groups due to potentially disclosure numbers.
- Patterns of immigration to Scotland over the last 18 years have changed, in particular among those from Eastern Europe, and we do not report on bowel screening uptake among these populations.
- The reported screening uptake rates are descriptive and not explanatory: although we adjusted for determinants of ethnic inequalities in bowel screening such as socio-economic status and UK birth, these made little difference to the patterns observed, and further potential mechanisms need to be explored.

boards (health authorities) in Scotland between June 2007 and December 2009, with those aged between 50 and 74 years and registered with a general practice invited to participate every 2 years.² Routine use of a faecal immunochemical test (FIT) was introduced in November 2017. Although progress has been made, substantial variation in uptake is still observed by deprivation;³ however, variation by ethnicity in Scotland has not been studied.

There is growing recognition of the challenges to minimising inequalities in cancer outcomes in minority ethnic populations across the UK. Recent work has demonstrated lower awareness of the breast and cervical

screening programmes compared with White survey participants and very low (less than 30% of respondents) awareness of bowel screening overall.⁴ Lower attendance among Asian invitees in the UK Flexible Sigmoidoscopy Trial has also been reported.⁵ The reasons for these differences are likely to include the approach of services, cultural beliefs and attitudes, and health communication and literacy barriers.^{6,7}

Reporting of inequalities in uptake of cancer screening by minority ethnic group has been limited by a failure in most health systems to routinely code ethnicity accurately. As a consequence, our understanding is based on area-based measures,^{8,9} responders to surveys including items on ethnicity,⁵ or name recognition software (eg, Nam Pehchan).¹⁰ Existing evidence is further limited by the use of very broad categories for ethnicity, for example, Indian subcontinent⁸; white/black/Asian⁵; Hindu-Gujerati/Hindu-Other/Muslim/Sikh/Other Asian.¹⁰ Within these constraints, variation in uptake has been observed internationally,¹¹ in the FOBt bowel screening pilots in England,^{10,12,13} and has been reported in the English Screening Programme.¹⁴ UK bowel screening databases (including Scotland) do not routinely include an ethnic code¹⁵ so reported estimated uptake rates by ethnicity are based on area-level characteristics rather than individual-level data. Findings from other parts of the UK may not be generalisable due to differences in composition of ethnic minority groups and religious affiliations, cultural background and service provision. A better understanding of both screening uptake and screening outcomes, analysed by minority ethnic groups and by religion, has the potential to inform more targeted education and informed choice strategies (although recognising that ethnicity, religion and cultural background are overlapping although not synonymous identities).

This study made use of a unique UK resource, the Scottish Health and Ethnicity Linkage Study (SHELS): linkage of the 2001 Census in Scotland (with individual level self-reported ethnicity, country of birth, religion and a range of sociodemographic characteristics), with the Community Health Index (CHI) register number and through that to other health databases.^{16,17} Linkage to the breast screening programme dataset enabled SHELS¹⁸ to demonstrate lower uptake of breast screening among minority ethnic women in Scotland, even when adjusted for several confounding factors. The primary aim of this paper was to describe bowel cancer screening uptake rates in detail by self-reported ethnic group, including White Scottish, other white British, white Irish, other White, Indian, Pakistani, Bangladeshi, other South Asian, Caribbean, African Other Black, Chinese, in addition to self-reported religious affiliation. Further, as previous SHELS linkage has shown lower directly age-standardised rates and ratios of colorectal cancer in the South Asian population in Scotland (especially in Pakistani men), as well as in Chinese men,¹⁹ linkage of census data with cancer registry has allowed us to examine test positivity, pathology and cancer outcomes by ethnic groups where available.

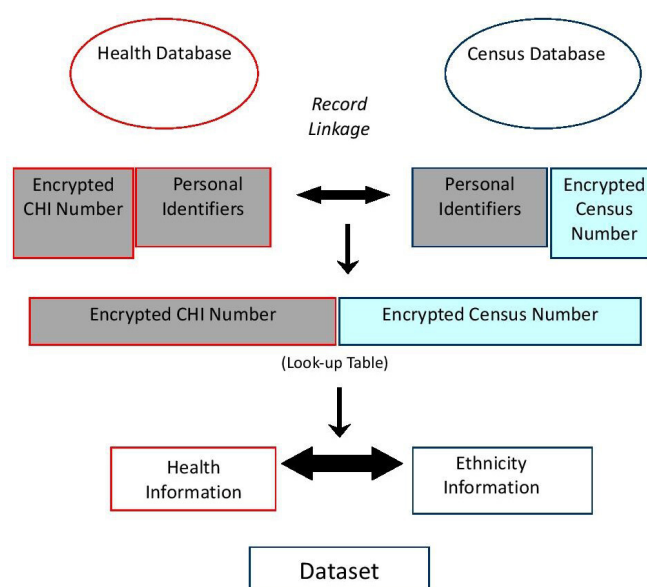


Figure 1 Scottish health and ethnicity linkage study—linkage of health and census datasets. CHI, Community Health Index.

METHODS

Data linkage

Methods of SHELS retrospective cohort studies have been published.^{16,17} We followed a strict protocol that preserved anonymity and maintained separation of personal data from the Census and NHS, and clinical data (figure 1). SHELS used computerised, probability matching of names, addresses, sex and dates of birth to link the Census 2001 for Scotland, to the CHI, which is a register of patients using the NHS. This created a file containing the linked encrypted CHI and encrypted census numbers for a cohort of 4.62 million people (95% of those completing the census and 90% of the estimated Scottish population in 2001). We used this file to link census variables to a previously linked Scottish Bowel Cancer Screening Programme (SBCSP) and Scottish Cancer Registry (SMR06) database.

Ethnicity and religious data

The Scottish Census 2001 provided ethnic group as reported by either individuals or the householder completing the form based on a question followed by a choice of 14 categories. Unless stated otherwise, we have used the official categories, capitalising them as in census reports. Ethnic group is a legally required field that was well completed (95.8%) and, after imputation (4.3%), available for 100% of those completing the census form.²⁰ If necessary because of small numbers, we aggregated the Bangladeshi group with the Other South Asian group; and the Caribbean, African and Black Scottish or other Black groups into one African origin group in order to comply with data release stipulations of the data controller. Any mixed background is one of the distinct ethnic categories in the Census, designed for use by people who perceive themselves as belonging to more than one ethnic group,

usually with each parent in a different ethnic group. Following our analytical strategy, ethnic groups were only omitted to avoid potential disclosure of identity. We did not report results for the 'all other' ethnic group as this is an exceptionally diverse group of people and it is difficult to interpret results in any meaningful way. Religion was recorded on the Scottish Census 2001 in specific categories based on both self-reported current religion and self-reported religion of upbringing.

Screening uptake

Individuals aged 50–74 years are invited to participate in bowel screening in Scotland every 2 years (a screening 'round'). Analyses were restricted by age to 50–74 years as the age range invited to participate in the screening programme, but we also examined screening uptake in the over 75s who chose to 'opt-in'.² Uptake of bowel screening was defined as a completed screening round using the FOBt (ie, screenee received a positive or negative test result).

Sociodemographic data

Census data included age, sex, country of birth (UK/Ireland (RoI) born or born outside UK/RoI) and socioeconomic status (SES). Four socioeconomic indicators were used: (1) the postcode-based Scottish Index of Multiple Deprivation, (2) highest qualification of the individual, (3) a combined measure of highest qualification (individual level for people aged 16–74 and household level for children and elderly, as individual data are not collected for these groups) and (4) household tenure.

Ninety-nine per cent of the White Scottish group, 50% of the Indian group, 59% of the Pakistani group, 42% of the Other South Asian group, 41% of the African origin group, 36% of the Chinese group and 28% of the other white group were born in the UK/RoI in our linked census database.

Outcomes

We primarily analysed uptake (persons successfully completing a kit and getting a final result that is, an outright positive or negative result) of bowel cancer screening between 2007 and 2013 in Scotland. First and second round (ie, where eligible participants are invited every 2 years) of screening were analysed separately. We further analysed the rate of positive screening test results in this participating population, and bowel cancer detection rates. The cohort of screening invitees analysed were those included in the Scottish Census 2001 who subsequently were still living in Scotland at the time of screening invitation. For analyses of screen detected invasive cancer, round 1 and round 2 (ie, where eligible participants are invited every 2 years) data were combined: round two figures include many of the same people as in round 1 results plus some newly entering the eligible age group, and who were resident at the 2001 Census.

Data analysis

We followed a prespecified analysis plan (<https://www.ed.ac.uk/usher/scottish-health-ethnicity-linkage/key-information>). We calculated, for each outcome, by sex and ethnic group: uptake in screening in both round 1 and round 2; age-adjusted rates per 100 000 population; risk ratios (RRs) and their 95% CI using Poisson regression with robust variance adjusted for age and subsequently adjusted for SES and country of birth. We multiplied the estimates by 100 to facilitate the interpretation of the results as percentages, as per the SHELS policy and analysis plan. We adopted a previously published approach for choosing variables that were potential confounding showing consistency across ethnic groups.¹⁶ Two SES indicators (household tenure and combined qualification) were consistently associated with the outcome across ethnic groups. The standard reference population was the White Scottish population. We also compared uptake rates by religion separately for men and women.

Data were analysed using SAS V.9.4 (SAS).

Limited availability of Grampian data

For technical reasons, data on pathology (polyps, adenoma, cancer) and invasive cancer were unavailable from Grampian Health Board.

Ethics and disclosure

Ethical and other permissions and related issues for SHELS methodology have been reported in detail including an independent assessment of SHELS' approach by an ethicist.^{16 17 21} To comply with the Data Protection Act and safe-setting rules the data set only contained specific disease outcomes. Other outcomes were excluded to minimise risks of inadvertent disclosure of identity. The analysis was conducted on a standalone computer in a locked room in the National Records of Scotland (NRS), by named researchers with appropriate clearance and training (LW, GC and MS) and following a strict disclosure protocol.

Outputs leaving the safe setting as well as this manuscript were reviewed by the NRS Disclosure Committee. The analysis was done on exact numbers. However, the released numerators and denominators were rounded to the nearest 5.

Authors developed a Directed Acyclic Graph to aid the interpretation of results and help generate areas for further investigation (online supplemental figure 1).

Patient and public involvement

SHELS established a Public Engagement Panel, comprised of a mix of ethnic groups, sexes and ages. This Public Engagement Panel provided patient and public involvement perspectives on SHELS methodological approach, including the research questions and design of this study. At the end of the study, results were shared with the Panel who commented on the findings and contributed to the dissemination plan.

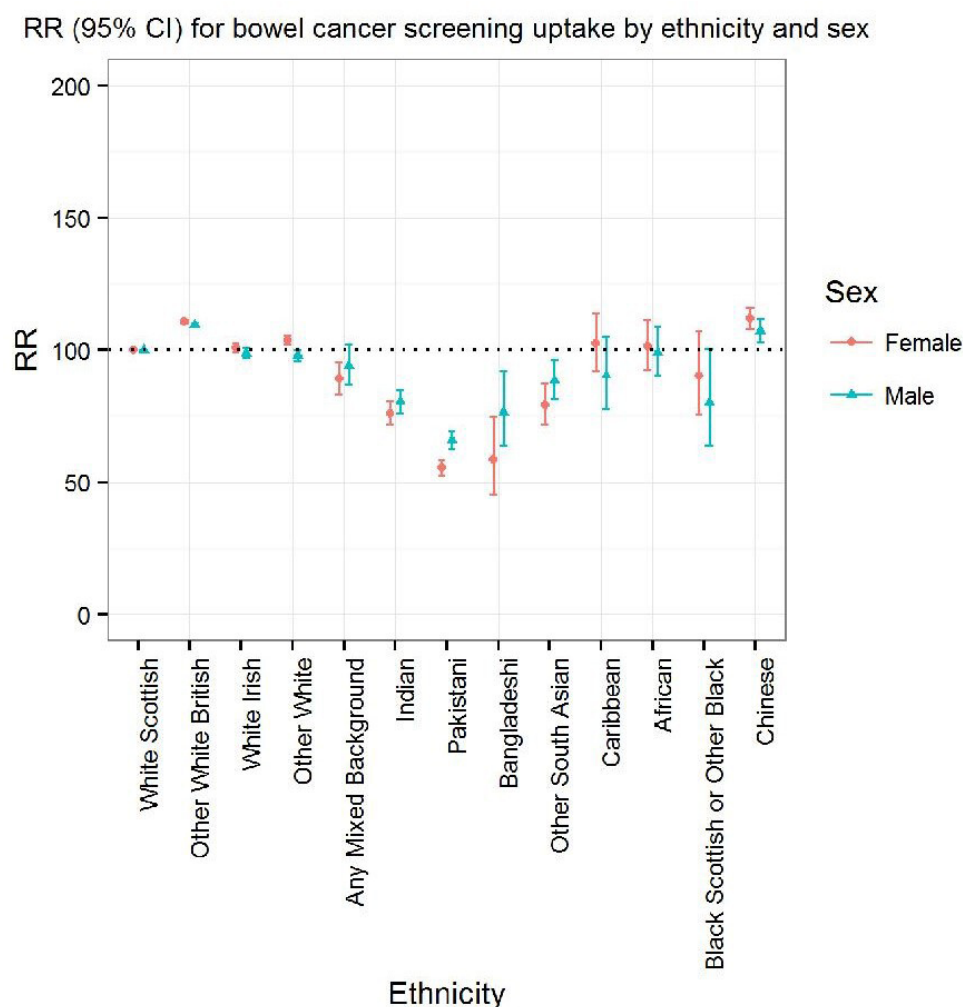


Figure 2 Bowel cancer screening uptake by ethnicity for round 1 relative to the white Scottish population: age-adjusted risk ratios (RRs).

RESULTS

Linkage

Linked data were available for 1 666 575 of 1 926 060 individuals invited to participate in round 1 screening, a linkage rate of 86.5%. Of the 1.67 million matched at round 1, 1 407 835 individuals were invited to round 2. We present here round 1 results, with round 2 results and additional analyses available in online supplemental tables 1A, B, 2A, B, 3A, B, 4A, B, 5A, B, 6A–D, 7A, B.

Uptake of bowel screening by ethnic group

Uptake in specific ethnic groups were compared with the White Scottish population, unless specified otherwise. **Figure 2** shows bowel cancer screening uptake in men and women for round 1 by ethnic group. For men, age-adjusted RRs were higher in the Other White British (RR (95% CI) 109.6 (108.8 to 110.3)) and Chinese (107.2 (102.8 to 111.8)) groups as they were more likely to return their kit once invited to screening compared with White Scottish men. Uptake was comparatively lower in other ethnic groups and especially so in Indian (80.5 (76.1 to 85.1)), Pakistani (65.9 (62.7 to 69.3)), Bangladeshi (76.6 (63.9 to 91.9)) and other South Asian (88.6 (81.8 to 96.1))

men. Further adjustment for UK/RoI-birth and SES did not greatly alter the associations apart from adjustment for UK/RoI-birth in Chinese men making their uptake converge towards the levels of uptake of White Scottish men (online supplemental table 1A).

Similarly in women (**figure 2**), age-adjusted RRs were higher in both Other White British (110.9 (95% CI 110.2 to 111.6)) and Chinese (112 (95% CI 108.2 to 115.9)) women compared with White Scottish women, and again uptake was comparatively lower in women from Indian (76.1 (95% CI 72 to 80.5)), Pakistani (55.5 (95% CI 52.5 to 58.8)), Bangladeshi 58.5 (95% CI 45.6 to 75.1)) and other South Asian (79.3 (95% CI 72 to 107.2)) ethnic groups. Further adjustment for UK-birth and SES did not alter the associations observed (online supplemental table 1B).

Screening uptake rates by ethnic group for round 2 showed similar patterns for both men and women.

Uptake of bowel screening by current religion and religion of upbringing

Figure 3 shows bowel cancer screening uptake in men and women for round 1 by self-reported current religion

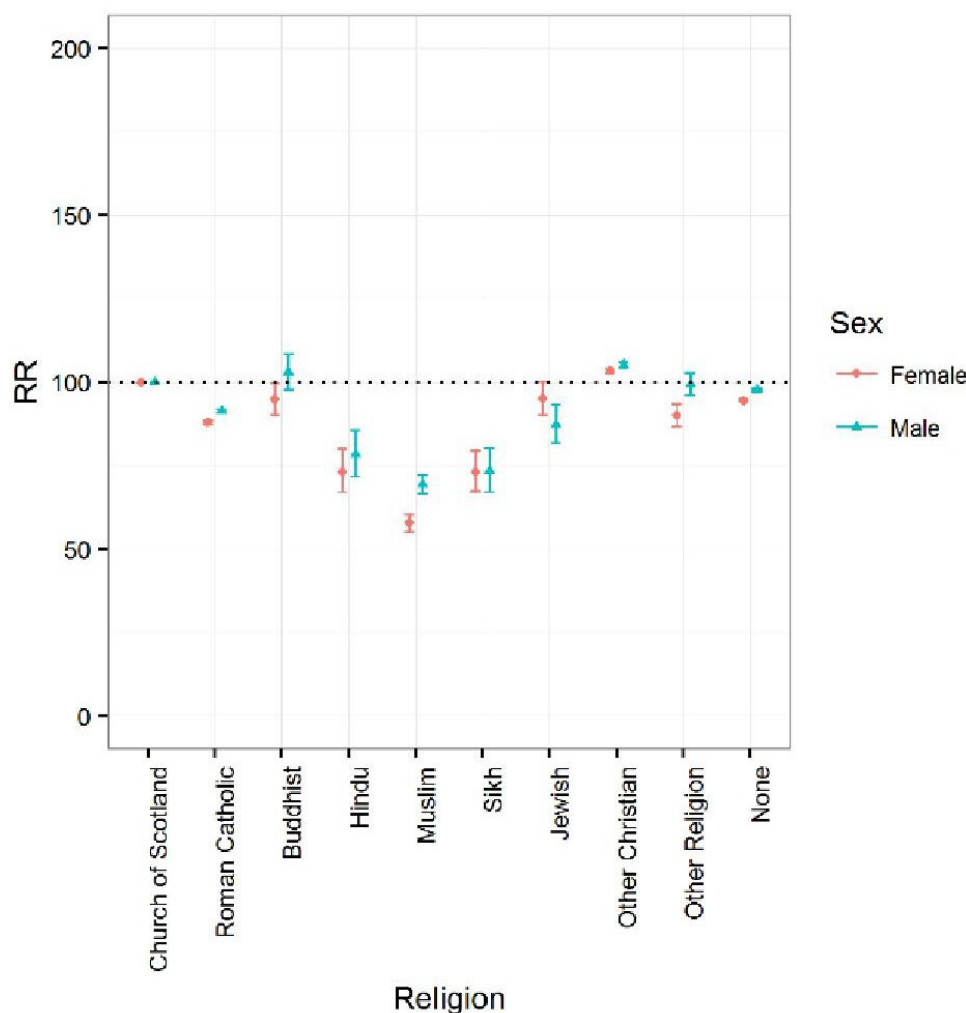


Figure 3 Bowel cancer screening uptake by religion for round 1 relative to the reference population (Church of Scotland): age-adjusted risk ratios (RRs). Campbell *et al* Ethnic and religious variations in bowel cancer screening in Scotland.

as in the 2001 Census. Age-adjusted RRs were lower among Hindu (RR (95% CI) 78.4 (71.8 to 85.6)), Muslim (69.5 (95% CI 66.7 to 72.3)), and Sikh (73.4 (95% CI 67.1 to 80.3)) men compared with those who identified current religion as Church of Scotland. Smaller differences compared with the reference population were observed among those who reported being Jewish (87.3 (95% CI 81.8 to 92.8)), Roman Catholic (91.4 (95% CI 90.8 to 92)), or none (no religion) (97.7 (95% CI 97.2 to 98.2)). Further adjustment for UK/RoI-birth and SES did not alter the trends observed.

In women, there was generally a lower uptake across groups compared with those who identified current religion as Church of Scotland apart from the Other Christian, with age-adjusted RRs being lower among Hindu (73.2 (95% CI 67 to 80)), Muslim (57.8 (95% CI 55.2 to 60.5)), and Sikh (73.2 (95% CI 67.4 to 79.5)) women compared with the reference Church of Scotland population. Age-adjusted RRs for Roman Catholic women were lower (87.9 (95% CI 87.4 to 88.4)) compared with the reference Church of Scotland populations; further

adjustment for UK-birth and SES only modestly reduced the differences.

Screening uptake rates by religion of upbringing for men (online supplemental table 2A) and women (online supplemental table 2B) showed overall similar patterns.

Screening uptake in round 2 for both current religion and religion of upbringing showed similar patterns.

Positivity of bowel screening test by ethnic group

Table 1 shows that age-adjusted RRs for positivity of FOBt were lower in Other White British (60.5 (95% CI 56.1 to 65.3)) men compared with White Scottish men in round 1. For women, positivity by ethnic group in round 1 (table 1) also showed lower positivity for the other White British group (67.3 (95% CI 61.6 to 73.5)) compared with White Scottish women. However, for selected other ethnic groups including Indian and Pakistani women there is some indication of lower test positivity rates compared with White Scottish women but CIs were wide due to the small sample size and straddling the reference value of 100. Similar patterns were seen in round 2 for both men and women.

Table 1 (A) Positive screen test results (round 1) by ethnic group in men: age-adjusted rates and risk ratios (RRs). RRs are adjusted for age, UK/Rol-born (vs born outside UK/Rol) and socioeconomic status (household tenure and combined individual and household level education) with 95% CIs. RRs (95% CIs): adjustment.(B) Positive screen test results (round 1) by ethnic group in women: age-adjusted rates and RRs. RRs are adjusted for age, UK/Rol-born (vs born outside UK/Rol) and socioeconomic status (household tenure and combined individual and household-level education) with 95% CIs. RRs (95% CIs): adjustment

Ethnic group	Positive screen test results	Completed screen kit returned	Rates/100 000	Age	Age and UK/Rol-born	Age and two socioeconomic variables	Age, UK/Rol-born and two socioeconomic variables
(A)							
Men							
White Scottish	11 100	362865	3060	100	100	100	100
Other White British	685	37040	1844	60.5 (56.1 to 65.3)	60.9 (56.4 to 65.7)	68.9 (63.8 to 74.5)	69.2 (64.1 to 74.7)
White Irish	130	4220	3081	98.6 (83.2 to 116.8)	98.7 (83.3 to 116.9)	99.5 (84 to 117.8)	99.5 (84 to 117.9)
Other White	110	4045	2770	96 (80 to 115.2)	111 (90.3 to 136.5)	104.6 (87.2 to 125.5)	115.3 (93.3 to 142.5)
Any mixed Background	10	310	2913	101.6 (53.1 to 194.5)	111.8 (58.4 to 213.9)	108.3 (56.8 to 206.6)	114.7 (60.2 to 218.7)
Indian	15	705	1844	58.7 (34.3 to 100.5)	71.6 (41.1 to 124.6)	67.6 (39.5 to 115.7)	76.9 (44.1 to 134)
Pakistani	20	1015	2172	74.8 (49.9 to 112.3)	92 (59.7 to 141.6)	74.5 (49.6 to 111.7)	85.3 (55.3 to 131.6)
Other South Asian	10	400	2764	105.2 (59.1 to 187)	126.9 (70.4 to 228.6)	113.2 (64 to 200.2)	127.3 (71.2 to 227.7)
African origin	10	360	2500	97.4 (51.1 to 185.7)	114.7 (59.4 to 221.2)	102.5 (53.8 to 195.4)	113.7 (58.9 to 219.4)
Chinese	30	990	3128	114.2 (80.9 to 161.3)	141.1 (96.7 to 205.7)	109.4 (77.4 to 154.5)	125.7 (86 to 183.7)
(B)							
Women							
White Scottish	8015	444425	1803	100	100	100	100
Other white British	510	42950	1187	67.3 (61.6 to 73.5)	67.3 (61.5 to 73.5)	76.4 (69.9 to 83.5)	76.2 (69.7 to 83.3)
White Irish	80	5255	1542	82.8 (66.7 to 102.7)	82.8 (66.7 to 102.7)	86.2 (69.5 to 107)	86.2 (69.5 to 107)
Other white	90	5840	1523	86.9 (70.7 to 106.8)	86.8 (67.1 to 112.3)	98.8 (80.3 to 121.5)	92.8 (71.2 to 120.8)
Any mixed Background	10	435	2771	169.8 (96.7 to 297.9)	169.6 (95.7 to 300.7)	173.6 (99.4 to 303.4)	167.5 (94.9 to 295.4)
Indian	10	690	1744	100.8 (58.2 to 174.5)	100.6 (57.1 to 177.3)	110.5 (63.8 to 191.4)	102.6 (58.1 to 181.3)
Pakistani	15	870	1724	106.5 (64.6 to 175.5)	106.2 (62.9 to 179.3)	98.6 (59.8 to 162.6)	91.2 (53.9 to 154.5)
Other South Asian	.	265					
African Origin	10	395	1515	98.2 (44.3 to 217.6)	98.1 (44 to 218.7)	107.2 (48.5 to 236.9)	101.1 (45.4 to 225.2)
Chinese	25	1210	2066	130.6 (88.9 to 191.8)	130.3 (85 to 199.9)	125.2 (85.4 to 183.5)	115.2 (75 to 177)

Table 2 Screen detected invasive cancer by ethnic group (rounds 1 and 2; men and women combined): age-adjusted rates and risk ratios (RRs)

Ethnic group	Cancers	Invited into screening	Rates/ 100 000	Age	Age and UK/Rol-born	Age and two socioeconomic variables	Age, UK/Rol-born and two socioeconomic variables
White Scottish	2025	2 428 585	83.4	100	100	100	100
Other White British	145	205 420	70.5	84 (71 to 99.3)	85 (71.8 to 100.5)	79.5 (67.1 to 94.1)	80.4 (67.9 to 95.2)
White Irish	25	29 770	77.3	86.5 (57.4 to 130.4)	86.6 (57.5 to 130.5)	86.7 (57.5 to 130.6)	86.7 (57.5 to 130.7)
Other white	20	28 620	71.2	92.5 (59.6 to 143.7)	130 (71.5 to 236.4)	88.9 (57.2 to 138)	127.1 (70.4 to 229.7)
*							

Results exclude Grampian health board. RRs are adjusted for sex, age, UK/Rol-born (vs born outside UK/Rol) and socioeconomic status (household tenure and combined individual and household level education) with 95% CIs. RRs (95% CIs): adjustment.

*Results for any mixed background, South Asian (Indian, Pakistan or other) or Chinese ethnic groups are not provided as they are so few as to be potentially disclosive (see the Methods section).

Bowel cancer detection and pathology by ethnic group

Table 2 shows bowel cancer detection rates via the screening test by ethnic group, for rounds 1 and 2, and for men and women combined, as this was necessary given the small numbers. Compared with the White Scottish population, other White British individuals had a lower age-adjusted RR of a diagnosis of screen-detected invasive cancer (84 (95% CI 71 to 99.3)); this result was not greatly altered after adjustment for UK-born and SES. Over the two rounds of screening, the number of invasive cancers found in individuals from other ethnic groups were too small to report for the risk of disclosure.

Online supplemental table 3A,B shows age-adjusted rates and RRs for pathology detected, for polyps, adenomas and cancer combined, for men and women, respectively. In comparison to the White Scottish population, numbers were small in each of the other ethnic groups. Only for Pakistani men was a lower rate of pathology detected (64.5 (95% CI 42.5 to 97.7)) compared with White Scottish men.

Uptake of bowel screening in older individuals

Individuals aged 75 and older are able to opt in to bowel screening in Scotland. Table 3 shows age-adjusted RRs for screening uptake by ethnic group for men and women, respectively. Chinese men had higher uptake (112.8 (95% CI 113.3 to 114.3)) compared with White Scottish men (table 3), as did Chinese women compared with White Scottish women (table 3: 116.7 (95% CI 115 to 118.5)). Adjustment for SES did not greatly affect this association in either Chinese men or women, however, further adjustment for UK-birth in Chinese men the RR converged towards that of white Scottish men.

DISCUSSION

Summary of findings

Although ethnic variation in colorectal screening uptake is increasingly recognised internationally,²² detailed description in relation to specific ethnic groups is lacking. We report complex patterns of variation in colorectal cancer screening uptake by ethnic group in Scotland,

with pronounced lower screening uptake among the South Asian groups compared with the White Scottish population, and higher uptake among the Chinese and other White British populations. We found little variation by ethnicity in later stages of the screening process.

Strengths and limitations of the study

Our results are to our knowledge the most fine-grained analyses of bowel screening uptake by ethnicity reported to date, and with a nationally tested classification of ethnic groups. For the first time, national Scottish Census 2001 data were used to show differences in uptake for separate Indian, Pakistani and Bangladeshi groups, for separate White groups, and for the first time showing uptake among Caribbean, African and Chinese groups as well as by religious groups. Additionally, SHELs benefits from high overall linkage rates of census and NHS CHI numbers (95%), with a large national population (4.62 million people), and in this study a high linkage rate with the Bowel Screening data (86%). However, we acknowledge that the small numbers of outcomes for some non-white populations has required aggregation of heterogeneous ethnic groups; for example, African, Caribbean, black, black Scottish or black British. For invasive cancers, we were unable to report on some ethnic groups due to reporting restrictions on potentially disclosive numbers (table 3). Given the constraints of data release for reasons of patient confidentiality, understanding patterns of uptake in some ethnic groups will require additional research in other settings where numbers within distinct ethnic groups are sufficiently large.

We are reporting on 2001 Census data. Immigration to Scotland over the last 18 years has affected the distribution of ethnic groups within Scotland^{23 24}; in particular, we do not report on bowel screening uptake among the Polish population, now one of Scotland's largest ethnic groups, where breast screening uptake is low.²⁵ Such analyses are not possible routinely and require a new study with linkage of bowel screening data to the 2011 Census. Nonetheless, the results reported here provide important

Table 3 (A) Bowel cancer screening uptake (round 1) by ethnic group in men aged 75 years and over: age adjusted rates and risk ratios (RRs) RRs are adjusted for UK/Rol-born (vs born outside UK/Rol) and socioeconomic status (household tenure and combined individual and household level education) with 95% RRs (95% CIs): adjustment. (B) Bowel cancer screening uptake (round 1) by ethnic group in women aged 75 years and over: age-adjusted rates and RRs. RRs are adjusted for UK/Rol-born (vs born outside UK/Rol) and socioeconomic status (household tenure and combined individual and household level education) with 95% CIs. RRs (95% CIs): adjustment

Ethnic group	Completed screen kit returned	Requested screening	Rates/100 000	Unadjusted	UK/Rol-born	Two socioeconomic variables	UK/Rol-born and two socioeconomic variables
(A)							
Men							
White Scottish	2460	2780	88489	100	100	100	100
Other White British	180	215	84186	95 (89.5 to 100.8)	94.7 (89.2 to 100.5)	94.4 (88.8 to 100.3)	94.2 (88.6 to 100)
White Irish	30	30	87500	98.7 (86.6 to 112.6)	98.5 (86.4 to 112.3)	98.5 (86.3 to 112.4)	98.3 (86.1 to 112.2)
Other White	20	25	88000	99.3 (85.9 to 114.8)	93.2 (78.9 to 110.1)	98.2 (85 to 113.4)	92.6 (78.6 to 109.2)
Any Mixed Background							
South Asian	15	20	76190.5	86 (67.7 to 109.2)	78.3 (60.8 to 100.8)	85.1 (67.3 to 107.7)	78.1 (60.8 to 100.4)
Chinese	10	10	100000	112.8 (111.3 to 114.3)	102.3 (93.6 to 111.7)	115.1 (110.3 to 120.1)	105.2 (95.3 to 116)
(B)							
Women							
White Scottish	2470	2885	85615.3	100	100	100	100
Other White British	170	195	87113.4	101.7 (96.1 to 107.5)	101.6 (96.1 to 107.5)	100.9 (95.3 to 106.8)	100.9 (95.3 to 106.8)
White Irish	30	30	90322.6	105.4 (93.9 to 118.4)	105.4 (93.9 to 118.4)	105.7 (94.1 to 118.9)	105.7 (94.1 to 118.9)
Other White	40	40	95000	110.9 (103.1 to 119.2)	110.3 (99.7 to 122.2)	110.3 (102.5 to 118.7)	109.9 (99.2 to 121.8)
Any Mixed Background							
South Asian	10	15	64705.9	75.5 (53.1 to 107.3)	75.1 (52.2 to 107.9)	75.3 (53.1 to 106.8)	75 (52.3 to 107.6)
Chinese	10	10	100000	116.7 (115 to 118.5)	116 (104.3 to 129)	117.7 (114.5 to 121)	117.2 (105.1 to 130.7)

insights into recent uptake patterns and set a benchmark for any future variation in bowel screening uptake rates as the population profile changes.

Finally, we recognise that the reported screening uptake rates are descriptive and not explanatory. We adjusted for determinants of ethnic inequalities in bowel screening such as SES and UK birth but these made little difference to the patterns observed. Further potential mechanisms need to be explored, including cultural and religious beliefs, and the influence (if any) of knowledge of or exposure to screening programmes in other health systems (see online supplemental figure 1 for potential variables influencing participation).

Data on a number of variables (pathology (polyps, adenoma, cancer) and invasive cancers) were unavailable from Grampian Health Board: sensitivity analyses (available on request) indicates that approximately 10%–12% of the denominator in the Scottish population were missing for these variables in the Scottish population. Grampian Health Board comprises only 10.1% of the Scottish population, and with a non-white Scottish population of 15% compared with 12% in Scotland overall, there is no reason to expect that inclusion of these data would have altered the observed patterns in (table 2).²⁶ Data on uptake rates were complete.

Existing literature

We found lower rates of screening uptake in South Asian populations, reflected in both ethnic group and current religion. Lower screening uptake among South Asian communities in the UK has been a feature of the screening programme since its inception^{8 9 12} and the factors influencing this are increasingly being understood. Many factors such as lack of awareness and understanding of the purpose of screening, and fear and fatalism about cancer are seen across all ethnic groups.^{6 27–30} However, limitations with English-language screening materials (translated materials often require request), the need to rely on younger family members, cultural difficulties associated with handling of faeces and social norms are additional barriers among South Asian ethnic groups.^{7 30} Differences in breast screening uptake by ethnic group in Scotland have been reported previously by our group (higher non-attendance rates to breast cancer screening among Pakistani, black, other South Asian and Indian women),¹⁸ as has variation in relation to numerous other health outcomes.^{31–33}

As mentioned, lower directly age-standardised rates and ratios of colorectal cancer in the South Asian population have been reported in Scotland.¹⁹ The RRs we report here suggesting lower RRs of FOBt positivity in Indian and Pakistani men (table 1) are consistent with this, although need to be interpreted with care due to wide CIs. Lower colorectal cancer rates in some ethnic communities may result in less perceived personal relevance and hence tailored educational interventions will need to acknowledge lower colorectal cancer rates while also addressing the identified barriers and facilitators.^{34–37}

There is a need for open discussion within bowel screening programmes and policy making of potentially variable benefits for different ethnic groups of screening uptake. The lower uptake rates may be appropriate for some groups, and genuine informed consent may require acknowledgement that some have less to gain in terms of absolute risk reduction. At a programmatic level, there is a balance between lower cancer risk and uptake of screening, and further work is warranted to address how issues of equality of access, cost-effectiveness and effectiveness are maintained. Although at a population level, the risk may be lower, messages aimed at the individual level need to communicate clearly the potential advantages of screening uptake within an informed choice framework.

The relatively high uptake rates among both Chinese men and women compared with the White Scottish men and women were unexpected, and not previously recognised in the Scottish population. Bansal *et al* found that age-adjusted RRs for breast screening uptake were similar among Chinese women compared with White Scottish women.¹⁸ High FOBt positivity rates were observed in both Chinese men and women in both rounds 1 and 2; this is despite the lack of evidence of higher incidence of colorectal cancer in the Chinese community in earlier SHELS work.¹⁹ Further research is warranted, not only to determine if these findings can be replicated in other Chinese communities in the UK, but also to explore any cultural or other factors underlying high screening uptake. Low awareness of colorectal cancer screening was found among Chinese participants in an EthniBus survey.⁴ Importantly, though, as noted above low rates of colorectal screening uptake (by flexible sigmoidoscopy) have been reported in areas of high non-white ethnicity but these were not broken down by ethnic group.³⁸

While numbers were relatively small, only limited variation in colorectal screening uptake was seen in the over 75 population; there is, however, some indication that South Asian men and women were less likely to opt-in. This is a self-selecting group of individuals who are likely to differ from their peers in terms of other health behaviours, motivation and levels of comorbidity. The low overall number of opt-ins is consistent with findings from the Bowel Screening Pilot in England.⁸

Implications for policy and practice

Addressing observed inequalities in screening uptake will require multifaceted interventions. Telephone-based interventions have been shown to increase colorectal screening uptake in ethnically diverse areas of London³⁹ but have resource implications. Patient navigators have been shown to be effective in some settings.⁴⁰ Further exploratory work and engagement with local communities is needed to develop, refine and test culturally appropriate interventions with salience to different ethnic groups; critically, these must ensure principles of informed choice are respected and incorporated throughout.⁴¹ Our reported variations in uptake by religion are, seemingly, novel: in particular, the lower uptake

among Roman Catholic populations compared with the reference population, persisting even when adjusted for socioeconomic variables, is puzzling. Addressing such variation by religion may be amenable to targeted faith-based interventions.⁴² Others have found variable influence of religiosity on screening uptake, with social support only partially mediating the relationship between religiosity and bowel screening uptake.⁴³ Comparing facilitators and barriers across groups may provide fresh insight into potential interventions.⁴⁴ Further, the introduction of the FIT in the SBCSP in late 2017 has been shown to increase overall screening uptake,² this provides an impetus to monitor the impact within ethnic groups over time (work currently underway by authors).

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Competing interests None declared.

Patient consent for publication Not required.

Ethics approval The work was approved by the Multicentre Research Ethics Committee for Scotland (16/12/2013, Scotland A REC Ref: 13/SS/0225) and the Privacy Advisory Committee of NHS National Services Scotland. Caldicott Guardian approval was obtained for access to SBCSP data. The study was performed in accordance with the Declaration of Helsinki.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data may be obtained from a third party and are not publicly available. Researchers who wish to access SHELS data should apply to National Records of Scotland (<https://www.nrscotland.gov.uk/>) and ISD (<http://www.isdscotland.org/>). They are maintained in a secure environment and governed by ethical and other restrictions on access.

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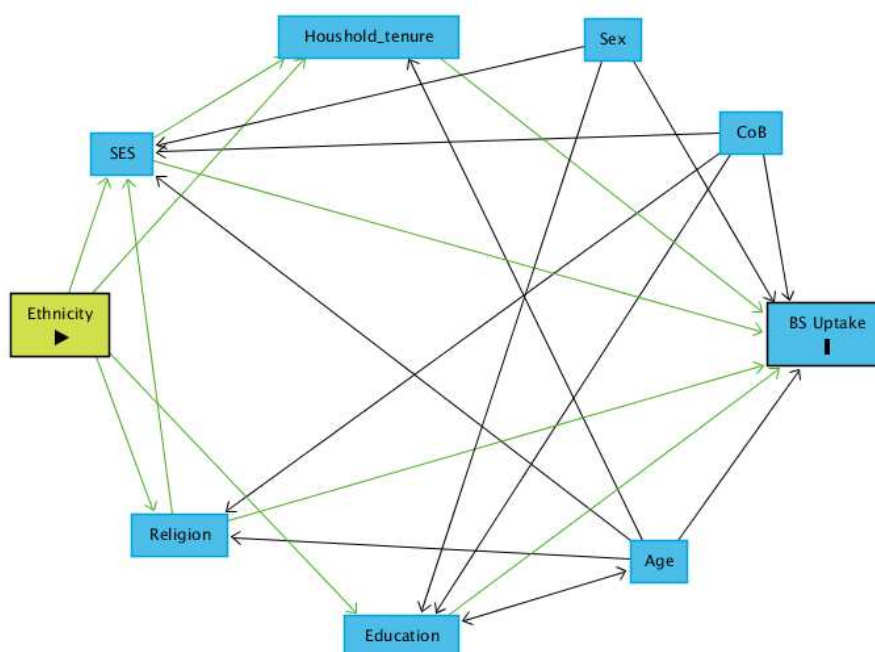
Supplementary Materials - Campbell et al Ethic and religious variations in bowel cancer screening in Scotland

Supplementary Material Figure 1

Directed Acrylic Graph (DAG) of factors influencing ethnicity and bowel screening uptake

A Directed Acrylic Graph (DAG) was developed, based on evidence form the literature, and discussion of study results. Initially 26 variables were identified as potential influencing factors to bowel screening uptake and a cross-matrix via expert opinion about the direction of influence between each of these variables was developed and tested for the causal effect identification in DAGitty v2.3 (<http://dagitty.net/dags.html>).

However, the initial model didn't allow estimation of the direct effect, and most of these variables were unobserved (latent) variables. The model was then stepwise reduced until a model was identified which allowed the estimation of the direct effects. The figure shows the final model for the minimal sufficient adjustment set for estimating the direct effect of ethnicity on bowel screening uptake, which included the variables age, country of birth, education, household tenure, religion, socioeconomic status (SES), and sex. This model informed the interpretation of our results and highlights areas for further investigation.



Initial factor set of 26 identified possible variables (observed variables in bold):

- **Ethnicity (Exposure)**
- **Bowel screening uptake (Outcome)**
- **Age**
- **Sex**
- Language
- Knowledge of screening
- Knowledge of cancer
- Previous experience of screening
- Health literacy
- **Education**
- Fatalism
- Perceptions of risk
- Fear of cancer
- Other priorities
- Self-efficacy
- Family history of cancer /illness
- **Country of birth (CoB)**
- **Socio-economic status**
- Marital status/ partnership
- **Religion**
- Cultural - including social norms
- Acculturation
- Frailty / co-morbidity
- **Rurality**
- Clinical support
- access to services

Supplementary Materials Tables for Campbell et al Are there ethnic and religious variations in uptake of bowel cancer screening in Scotland?

Supplementary Material Table 1A. Bowel cancer screening uptake (Round 1) by ethnic group in men: age adjusted rates and risk ratios (RR). RRs are adjusted for age, UK-born (versus born outside UK) and socio-economic status (household tenure and combined individual and household level education) with 95% confidence intervals (CIs).

RRs (95% CIs): adjustment							
Ethnic group	Completed screen kit returned	Invited into screening	Rates/ 100,000	Age	Age and UK/Rol-born	Age and 2 socio-economic variables	Age, UK/Rol-born and 2 socio-economic variables
MEN							
White Scottish	362865	698715	51933	100	100	100	100
Other White British	37040	64855	57121	109.6 (108.8, 110.3)	109.5 (108.7, 110.2)	103 (102.2, 103.7)	102.9 (102.2, 103.7)
White Irish	4220	8155	51646	98.9 (96.9, 101)	98.9 (96.8, 101)	98.2 (96.2, 100.2)	98.2 (96.2, 100.2)
Other White	4045	8035	50320	98.1 (95.9, 100.2)	95.7 (93.4, 98.2)	94.7 (92.7, 96.8)	94.5 (92.2, 96.8)
Any Mixed Background	310	645	48094	94.1 (86.9, 102)	92.9 (85.7, 100.7)	94.5 (87.4, 102.3)	94.4 (87.2, 102.2)
Indian	705	1700	41495	80.5 (76.1, 85.1)	78 (73.6, 82.7)	75.4 (71.3, 79.7)	75.1 (70.9, 79.6)
Pakistani	1015	3040	33337	65.9 (62.7, 69.3)	63.7 (60.4, 67.2)	65.6 (62.4, 69)	65.4 (62, 68.9)
Bangladeshi	70	180	39013	76.6 (63.9, 91.9)	74.1 (61.8, 89)	77.9 (65.2, 93.1)	77.6 (64.9, 92.9)
Other South Asian	325	735	44492	88.6 (81.8, 96.1)	85.9 (79.1, 93.2)	86.4 (79.7, 93.7)	86.1 (79.4, 93.5)
Caribbean	90	200	45502	90.4 (77.7, 105.1)	88.5 (76.1, 102.9)	89.3 (76.7, 103.9)	89.1 (76.5, 103.7)
African	225	450	49560	99.1 (90.3, 108.7)	96.1 (87.5, 105.5)	99 (90.3, 108.6)	98.7 (89.9, 108.4)
Black Scottish or Other Black	45	110	40911	80.2 (64, 100.6)	79.2 (63.1, 99.4)	84 (67.2, 105)	83.9 (67.1, 104.9)
Chinese	990	1815	54579	107.2 (102.8, 111.8)	103.6 (99, 108.4)	107.4 (103, 112)	107 (102.3, 111.9)

Supplementary Materials Tables for Campbell et al Are there ethnic and religious variations in uptake of bowel cancer screening in Scotland?

Supplementary Material Table 1B. Bowel cancer screening uptake (round 1) by ethnic group in women: age adjusted rates and risk ratios (RR). RRs are adjusted for age, UK-born (versus born outside UK) and socio-economic status (household tenure and combined individual and household level education) with 95% confidence intervals (CIs).

RRs (95% CIs): adjustment							
Ethnic group	Completed screen kit returned	Invited into screening	Rates/100000	Age	Age and UK/Rol-born	Age and 2 socio-economic variables	Age, UK/Rol-born and 2 socio-economic variables
WOMEN							
White Scottish	444425	773555	57452	100	100	100	100
Other White British	42950	67160	63955	110.9 (110.2, 111.6)	110.8 (110.1, 111.4)	104.4 (103.8, 105.1)	104.4 (103.8, 105.1)
White Irish	5255	9005	58370	100.9 (99.2, 102.7)	100.9 (99.2, 102.7)	98.6 (96.9, 100.3)	98.6 (96.9, 100.3)
Other White	5840	9825	59472	103.8 (102.1, 105.5)	101 (99, 103)	97.8 (96.3, 99.4)	97.5 (95.6, 99.4)
Any Mixed Background	435	855	50564	89.2 (83.5, 95.4)	87.9 (82.3, 94)	89.2 (83.6, 95.2)	89 (83.4, 95.1)
Indian	690	1585	43409	76.1 (72, 80.5)	73.6 (69.5, 78)	72.3 (68.4, 76.4)	72 (68, 76.2)
Pakistani	870	2785	31233	55.5 (52.5, 58.6)	53.6 (50.6, 56.7)	56.7 (53.6, 59.9)	56.4 (53.3, 59.7)
Bangladeshi	40	130	32988	58.5 (45.6, 75.1)	56.7 (44.1, 72.8)	59.1 (46.2, 75.5)	58.8 (46, 75.2)
Other South Asian	225	500	45144	79.3 (72, 87.4)	77 (69.9, 84.8)	78.5 (71.5, 86.3)	78.2 (71.1, 86.1)
Caribbean	145	250	57998	102.6 (92.4, 113.9)	100.4 (90.4, 111.5)	97.3 (87.8, 107.8)	97 (87.5, 107.6)
African	190	330	57445	101.6 (92.6, 111.5)	98.4 (89.6, 108.1)	99.6 (90.8, 109.3)	99.2 (90.4, 109)
Black Scottish or Other Black	60	120	51665	90.2 (75.8, 107.2)	88.9 (74.7, 105.7)	92.7 (78.4, 109.6)	92.6 (78.3, 109.4)
Chinese	1210	1915	63190	112 (108.2, 115.9)	108 (104, 112.1)	111.7 (107.9, 115.6)	111.2 (107.1, 115.4)

Supplementary Materials Tables for Campbell et al Are there ethnic and religious variations in uptake of bowel cancer screening in Scotland?

Supplementary Material Table 2A. Bowel cancer screening uptake (Round 2) by ethnic group in men: age adjusted rates and risk ratios (RRs). RRs are adjusted for age, UK/Rol-born (versus born outside UK/Rol) and socio-economic status (household tenure and combined individual and household level education) with 95% confidence intervals (CIs).

RRs (95% CIs): adjustment							
Ethnic group	Completed screen kit returned	Invited into screening	Rates/ 100,000	Age	Age and UK/Rol-born	Age and 2 socio-economic variables	Age, UK/Rol-born and 2 socio-economic variables
MEN							
White Scottish	324520	590540	54952.7	100	100	100	100
Other White British	33190	55265	60056.8	108.5 (107.5, 109.6)	108.4 (107.3, 109.4)	102.4 (101.2, 103.7)	102.4 (101.2, 103.6)
White Irish	3770	6850	55073	99.7 (97.5, 101.9)	99.6 (97.5, 101.9)	99.2 (97, 101.4)	99.2 (97, 101.4)
Other White	3595	6650	54091.4	108 (91.8, 127.1)	104.3 (90.9, 119.6)	103.7 (89.5, 120.1)	102.3 (90.4, 115.8)
Any Mixed Background	265	505	52870.6	96.9 (89.2, 105.3)	95 (87.3, 103.4)	97.4 (89.7, 105.7)	96.6 (88.9, 105)
Indian	645	1440	44729	81.3 (76.8, 86.2)	77.6 (72.3, 83.3)	77.1 (72.8, 81.6)	75.7 (70.6, 81.1)
Pakistani	905	2565	35298.3	65.2 (61.7, 68.8)	62 (57.7, 66.7)	65.6 (62.1, 69.2)	64.3 (59.7, 69.2)
Bangladeshi	60	145	41666.1	76.5 (62.9, 92.9)	72.8 (59.6, 88.8)	77.1 (63.9, 93)	75.6 (62.4, 91.6)
Other South Asian	295	620	47895.8	89 (81.8, 96.8)	84.9 (77.4, 93.3)	87.1 (80.1, 94.6)	85.5 (78, 93.7)
Caribbean	75	160	46874.4	86.6 (73.5, 102.2)	83.8 (70.8, 99.1)	85.4 (72.4, 100.8)	84.3 (71.3, 99.7)
African	180	345	51872.5	96.1 (86.6, 106.6)	91.8 (82.1, 102.5)	95.7 (86.3, 106)	94 (84.2, 104.8)
Black Scottish or Other Black	45	90	46738.5	86.2 (69.3, 107.3)	84.6 (68, 105.3)	89.7 (72.3, 111.2)	89 (71.8, 110.4)
Chinese	890	1505	59162.6	108 (103.2, 113.1)	102.7 (96.3, 109.6)	109.6 (104.7, 114.8)	107.4 (100.5, 114.9)

Supplementary Materials Tables for Campbell et al Are there ethnic and religious variations in uptake of bowel cancer screening in Scotland?

Supplementary Material Table 2B. Bowel cancer screening uptake (Round 2) by ethnic group in women: age adjusted rates and risk ratios (RRs). RRs are adjusted for age, UK/Rol-born (versus born outside UK/Rol) and socio-economic status (household tenure and combined individual and household level education) with 95% confidence intervals (CIs).

RRs (95% CIs): adjustment							
Ethnic group	Completed screen kit returned	Invited into screening	Rates/100.000	Age	Age and UK/Rol-born	Age and 2 socio-economic variables	Age, UK/Rol-born and 2 socio-economic variables
WOMEN							
White Scottish	388730	654990	59348.8	100	100	100	100
Other White British	37600	57050	66369.9	110.7 (110, 111.4)	110.4 (109.8, 111.1)	104.5 (103.9, 105.1)	104.4 (103.8, 105.1)
White Irish	4610	7625	60891.6	101 (99.2, 102.9)	101 (99.2, 102.9)	98.9 (97.1, 100.7)	98.9 (97.1, 100.7)
Other White	5090	8215	107045.9	104.7 (102.9, 106.5)	100.2 (98.2, 102.3)	98.8 (97.2, 100.5)	97 (95, 98.9)
Any Mixed Background	390	710	55407.6	94.1 (88, 100.5)	91.8 (85.8, 98.1)	94.3 (88.3, 100.6)	93.2 (87.3, 99.5)
Indian	620	1355	45997	77.6 (73.3, 82.2)	73.5 (69.3, 78)	73.8 (69.6, 78.1)	72 (67.9, 76.4)
Pakistani	795	2330	34324.4	58.9 (55.6, 62.3)	55.6 (52.5, 59)	59.9 (56.7, 63.4)	58.5 (55.2, 62)
Bangladeshi	40	110	35432.3	60.7 (46.8, 78.7)	57.6 (44.4, 74.7)	60.4 (46.9, 77.8)	59 (45.8, 76.1)
Other South Asian	200	405	49852.6	84.2 (76.4, 92.9)	80.2 (72.7, 88.6)	83.1 (75.3, 91.6)	81.3 (73.6, 89.7)
Caribbean	120	210	57819.5	98.2 (87.5, 110.2)	94.6 (84.2, 106.1)	93.2 (83.1, 104.6)	91.7 (81.7, 102.8)
African	165	270	62375.3	105.8 (96.3, 116.2)	100.4 (91.3, 110.4)	103.1 (93.7, 113.5)	100.8 (91.5, 111.1)
Black Scottish or Other Black	45	95	49809.7	83.8 (68.6, 102.4)	81.7 (66.9, 99.8)	84.9 (70.1, 102.8)	83.9 (69.2, 101.6)
Chinese	1080	1605	67867.3	115.7 (111.8, 119.8)	109.1 (105.1, 113.3)	115.2 (111.3, 119.2)	112.2 (108.1, 116.5)

Supplementary Materials Tables for Campbell et al Are there ethnic and religious variations in uptake of bowel cancer screening in Scotland?

Supplementary Material Table 3A. Bowel cancer screening uptake (Round 1) by country of birth in men: age adjusted rates and risk ratios (RRs). RRs are adjusted for age and socio-economic status (household tenure and combined individual and household level education) with 95% confidence intervals (CIs).

RRs (95% CIs): adjustment					
Country of birth	Completed screen kit returned	Invited into screening	Rates/ 100,000	Age	Age and 2 socio- economic variables
MEN					
Scotland	355310	685975	51796.4	100	100
Northern Ireland	2720	4890	55376.5	107 (104.4, 109.7)	102.9 (100.4, 105.4)
Rep Ireland	1695	3240	52218.9	97.8 (94.6, 101.1)	99.3 (96.2, 102.6)
Other UK	42015	73785	56952.8	109.6 (108.9, 110.3)	103.2 (102.5, 103.9)
India	1070	2240	47726.8	90.1 (86.3, 94)	83.8 (80.3, 87.4)
Pakistan	855	2670	32067.9	63.8 (60.4, 67.4)	63.5 (60.1, 67.1)
Bangladesh	80	195	40936.1	81 (68.4, 96.1)	80.9 (68.4, 95.6)
China	185	345	53606.9	102.3 (92.8, 112.8)	100.1 (90.9, 110.2)
Hong Kong	815	1470	55631.6	110 (105.1, 115.2)	110 (105.1, 115.1)
Africa	1715	3330	51506.8	102.1 (98.8, 105.5)	96.2 (93.1, 99.4)
Caribbean and West Indies	130	245	52873.4	102.8 (91.5, 115.5)	96.2 (85.6, 108)
Rest of the World	5740	11135	51544.3	101.6 (99.8, 103.5)	97.7 (96, 99.5)

Supplementary Materials Tables for Campbell et al Are there ethnic and religious variations in uptake of bowel cancer screening in Scotland?

Supplementary Material Table 3B. Bowel cancer screening uptake (Round 1) by country of birth in women: age adjusted rates and risk ratios (RRs). RRs are adjusted for age and socio-economic status (household tenure and combined individual and household level education) with 95% confidence intervals (CIs).

RRs (95% CIs): adjustment					
Country of birth	Completed screen kit returned	Invited into screening	Rates/ 100,000	Age	Age and 2 socio-economic variables
WOMEN					
Scotland	435740	760005	57333.7	100	100
Northern Ireland	3410	5490	62120	108.1 (105.9, 110.4)	103.4 (101.4, 105.6)
Rep Ireland	2615	4365	59889.6	102.8 (100.3, 105.3)	101.7 (99.3, 104.1)
Other UK	47935	75540	63453.7	110.4 (109.7, 111)	104.3 (103.7, 104.9)
India	1065	2110	50385.7	86.9 (83.3, 90.6)	81.1 (77.8, 84.6)
Pakistan	780	2455	31807.7	56.6 (53.4, 60)	57.8 (54.6, 61.2)
Bangladesh	45	120	38227.6	67.8 (53.9, 85.4)	66.9 (53.3, 83.9)
China	275	435	62469.5	110.7 (103, 119.1)	108.5 (101, 116.7)
Hong Kong	850	1350	62987.5	112.6 (108, 117.3)	112.9 (108.4, 117.7)
Africa	1860	3110	59869.6	106 (103, 109.1)	99.5 (96.7, 102.4)
Caribbean and West Indies	220	335	66064.1	115.8 (107.3, 125.1)	105.7 (97.9, 114.1)
Rest of the World	8115	13755	59017.1	104.1 (102.7, 105.6)	98.9 (97.5, 100.2)

Supplementary Materials Tables for Campbell et al Are there ethnic and religious variations in uptake of bowel cancer screening in Scotland?

Supplementary Material Table 4A. Bowel cancer screening uptake (Round 1) by religion of upbringing in men: age adjusted rates and risk ratios (RRs). RRs are adjusted for age, UK/Rol-born (versus born outside UK/Rol) and socio-economic status (household tenure and combined individual and household level education) with 95% confidence intervals (CIs).

RRs (95% CIs): adjustment							
Religion of upbringing	Completed screen kit returned	Invited into screening	Rates/ 100,000	Age	Age and UK/Rol-born	Age and 2 socio-economic variables	Age, UK/Rol-born and 2 socio-economic variables
MEN	243955	450020	54209.6	100	100	100	100
Church of Scotland							
Roman Catholic	66100	134685	48802.5	91.9 (91.3, 92.4)	91.8 (91.2, 92.3)	94.6 (94, 95.1)	94.6 (94, 95.1)
Buddhist	250	495	50604.3	94.8 (86.9, 103.4)	91.9 (84.2, 100.3)	96.2 (88.2, 105)	96.1 (88, 105)
Hindu	325	730	44185.5	81.2 (74.9, 88)	78.5 (72.3, 85.2)	74.3 (68.5, 80.5)	74.2 (68.3, 80.6)
Muslim	1615	4410	36626.2	70 (67.4, 72.8)	67.7 (64.9, 70.5)	70.4 (67.7, 73.2)	70.4 (67.5, 73.3)
Sikh	310	800	38923.2	73.6 (67.5, 80.3)	71.5 (65.6, 78.1)	72.2 (66.3, 78.7)	72.2 (66.2, 78.7)
Jewish	585	1240	46939.9	86.3 (81.4, 91.6)	86.1 (81.1, 91.3)	81.6 (77, 86.6)	81.6 (77, 86.6)
Other Christian	42550	72280	58868.5	108.2 (107.5, 108.9)	108 (107.3, 108.7)	103 (102.3, 103.7)	103 (102.3, 103.7)
Other Religion	370	825	44848	85.2 (79, 91.9)	84.8 (78.6, 91.4)	84.3 (78.3, 90.9)	84.3 (78.3, 90.9)
None	38330	83260	46036.6	88.1 (87.4, 88.8)	88 (87.3, 88.7)	91.5 (90.8, 92.2)	91.5 (90.8, 92.2)

Supplementary Materials Tables for Campbell et al Are there ethnic and religious variations in uptake of bowel cancer screening in Scotland?

Supplementary Material Table 4B. Bowel cancer screening uptake (Round 1) by religion of upbringing in women: age adjusted rates and risk ratios (RRs). RRs are adjusted for age, UK/Rol-born (versus born outside UK/Rol) and socio-economic status (household tenure and combined individual and household level education) with 95% confidence intervals (CIs).

RRs (95% CIs): adjustment							
Religion of upbringing	Completed screen kit returned	Invited into screening	Rates/ 100,000	Age	Age and UK/Rol-born	Age and 2 socio-economic variables	Age, UK/Rol-born and 2 socio-economic variables
WOMEN	300940	499325	60269	100	100	100	100
Church of Scotland							
Roman Catholic	83420	156940	53154	88.9 (88.4, 89.4)	88.8 (88.3, 89.2)	91.5 (91.1, 92)	91.5 (91, 92)
Buddhist	400	710	56336.8	95.4 (89.4, 101.8)	90.1 (84.4, 96.2)	96.5 (90.5, 102.9)	95 (89, 101.4)
Hindu	280	645	43584.8	72.4 (66.3, 79)	68.3 (62.5, 74.6)	67.1 (61.5, 73.3)	66.1 (60.5, 72.2)
Muslim	1090	3265	33363.3	56.5 (53.8, 59.3)	53.3 (50.7, 56.1)	58.4 (55.6, 61.2)	57.4 (54.7, 60.4)
Sikh	340	790	43061.2	72.3 (66.7, 78.3)	68.9 (63.6, 74.7)	72.7 (67.2, 78.8)	71.8 (66.2, 77.8)
Jewish	705	1235	57014.2	93.7 (89.2, 98.3)	92.9 (88.5, 97.5)	88.4 (84.3, 92.8)	88.2 (84.1, 92.6)
Other Christian	55265	85070	64964.8	107.4 (106.9, 108)	107.1 (106.5, 107.7)	102.9 (102.4, 103.5)	102.8 (102.3, 103.4)
Other Religion	365	700	51924.7	87.2 (81.2, 93.6)	86.3 (80.4, 92.6)	88.6 (82.6, 95)	88.3 (82.4, 94.7)
None	34110	68420	49855.9	85 (84.3, 85.6)	84.8 (84.1, 85.5)	90.3 (89.6, 91)	90.2 (89.5, 90.9)

Supplementary Materials Tables for Campbell et al Are there ethnic and religious variations in uptake of bowel cancer screening in Scotland?

Supplementary Material Table 5A. Positive screen test results (Round 2) by ethnic group in men: age adjusted rates and risk ratios (RRs). RRs are adjusted for age, UK/Rol-born (versus born outside UK/Rol) and socio-economic status (household tenure and combined individual and household level education) with 95% confidence intervals (CIs).

RRs (95% CIs): adjustment							
Ethnic group	Positive screen test results	Completed screen kit returned	Rates/ 100,000	Age	Age and UK/Rol-born	Age and 2 socio-economic variables	Age, UK/Rol-born and 2 socio-economic variables
MEN	10540	324520	3248.2	100	100	100	100
White Scottish	705	33190	2124	65.3 (60.5, 70.4)	65.5 (60.8, 70.6)	74.3 (68.8, 80.2)	74.4 (68.9, 80.3)
Other White British	145	3770	3870.6	117.2 (100.1, 137.3)	117.3 (100.1, 137.3)	118 (100.8, 138.2)	118 (100.8, 138.2)
White Irish	105	3595	2892.1	91.8 (75.9, 110.9)	101.2 (80.6, 126.9)	100 (82.7, 120.9)	104.7 (82.9, 132.1)
Other White	10	265	4494.3	144.4 (83, 251.3)	152.4 (87, 267.1)	146.8 (84, 256.6)	150.3 (85.4, 264.6)
Any Mixed Background	20	645	2790.7	86.3 (54.6, 136.4)	98.5 (60.5, 160.3)	100.1 (63.5, 157.9)	106.3 (65.4, 172.8)
Indian	25	905	2761.6	85.1 (57.6, 125.5)	97.8 (63.6, 150.4)	84.1 (57, 124.1)	89.6 (58.2, 138.2)
Pakistani	10	355	3370.8	120 (68.8, 209.2)	137 (76.8, 244.3)	134.5 (77, 234.8)	142.7 (80, 254.6)
Other South Asian	10	300	3020.1	107.3 (56.3, 204.2)	119.9 (62.1, 231.2)	113.9 (59.8, 216.9)	119.8 (62.1, 231)
African origin	30	890	3254.7	111.8 (78.6, 159.1)	128.7 (87, 190.3)	107.6 (75.8, 152.8)	114.8 (77.6, 169.8)
Chinese							

Supplementary Materials Tables for Campbell et al Are there ethnic and religious variations in uptake of bowel cancer screening in Scotland?

Supplementary Material Table 5B. Positive screen test results (Round 2) by ethnic group in women: age adjusted rates and risk ratios (RRs). RRs are adjusted for age, UK/Rol-born (versus born outside UK/Rol) and socio-economic status (household tenure and combined individual and household level education) with 95% confidence intervals (CIs).

RRs (95% CIs): adjustment							
Ethnic group	Positive screen test results	Completed screen kit returned	Rates/ 100,000	Age	Age and UK/Rol-born	Age and 2 socio-economic variables	Age, UK/Rol-born and 2 socio-economic variables
WOMEN	8050	388730	2070.9	100	100	100	100
White Scottish	490	37600	1300.5	63.8 (58.3, 69.8)	64.2 (58.6, 70.2)	71.6 (65.4, 78.4)	71.8 (65.6, 78.7)
Other White British	90	4610	1973.9	91.8 (75, 112.3)	91.8 (75, 112.4)	93.9 (76.7, 114.9)	93.9 (76.7, 114.9)
White Irish	70	5090	1375.5	68.3 (54.2, 86.2)	78.7 (60, 103.3)	76.8 (60.9, 96.9)	84 (63.7, 110.8)
Other White	10	390	2561.7	132.2 (72.5, 241)	143.8 (77.9, 265.3)	134.2 (73.2, 246.1)	140.9 (76.1, 261.1)
Any Mixed Background	10	620	1291.6	64.5 (32.2, 129)	77.1 (37.3, 159.3)	69.9 (35, 139.6)	78.1 (37.8, 161.3)
Indian	20	795	2644.8	141.7 (92.6, 216.9)	169.7 (107.5, 268)	132.7 (86.8, 202.8)	148.6 (93.8, 235.4)
Pakistani	.	240					
Other South Asian	10	330	2108.4	109.7 (52.6, 228.8)	127 (60.4, 267.4)	119.1 (57.3, 247.5)	130.4 (62.1, 273.6)
African origin	20	1080	2032.6	112.6 (74.3, 170.7)	136.5 (85.8, 217.2)	108.5 (71.5, 164.7)	122.5 (76.7, 195.8)
Chinese							

Supplementary Materials Tables for Campbell et al Are there ethnic and religious variations in uptake of bowel cancer screening in Scotland?

Supplementary Material Table 6A. Colonoscopy performed (Round 1) by ethnic group in men: age adjusted rates and risk ratios (RRs). Results exclude Grampian health board. RRs are adjusted for age, UK/Rol-born (versus born outside UK/Rol) and socio-economic status (household tenure and combined individual and household level education) with 95% confidence intervals (CIs).

RRs (95% CIs): adjustment							
Ethnic group	Colonoscopy performed	Positive screen test results	Rates/ 100,000	Age	Age and UK/Rol-born	Age and 2 socio-economic variables	Age, UK/Rol-born and 2 socio-economic variables
MEN							
White Scottish	8380	10125	82765.4	100	100	100	100
Other White British	495	595	83172.7	100.6 (98.1, 103.1)	100.5 (98, 103)	100 (97.5, 102.5)	99.9 (97.4, 102.4)
White Irish	100	125	78144.9	94.5 (88, 101.5)	94.6 (88.1, 101.5)	94.7 (88.2, 101.7)	94.7 (88.2, 101.7)
Other White	80	95	83447.6	100.8 (95, 107)	97.6 (91.4, 104.2)	100.5 (94.7, 106.7)	97.5 (91.4, 104.1)
Any Mixed Background	.	10					
Indian	10	10	89866.7	108.9 (107.9, 109.8)	103.6 (99.7, 107.7)	108 (106.8, 109.1)	103.2 (99.2, 107.4)
Pakistani	15	20	76386.7	92.2 (76.7, 111)	88 (73, 106.2)	92 (76.3, 110.9)	88.2 (72.9, 106.5)
Other South Asian	10	10	79881.5	96.5 (76.4, 121.8)	92.8 (73.4, 117.4)	96.8 (76.3, 122.7)	93.4 (73.5, 118.7)
African origin	10	10	77028.6	93.1 (68.8, 125.9)	90.5 (67, 122.2)	93.1 (68.4, 126.6)	90.7 (66.8, 123.2)
Chinese	20	30	81307.9	98.3 (85.6, 112.9)	93.8 (81.4, 108.2)	98.1 (85.6, 112.5)	94 (81.6, 108.2)

Supplementary Materials Tables for Campbell et al Are there ethnic and religious variations in uptake of bowel cancer screening in Scotland?

Supplementary Material Table 6B. Colonoscopy performed (Round 1) by ethnic group in women: age adjusted rates and risk ratios (RRs). Results exclude Grampian health board. RRs are adjusted for age, UK/Rol-born (versus born outside UK/Rol) and socio-economic status (household tenure and combined individual and household level education) with 95% confidence intervals (CIs).

RRs (95% CIs): adjustment							
Ethnic group	Colonoscopy performed	Positive screen test results	Rates/ 100,000	Age	Age and UK/Rol-born	Age and 2 socio-economic variables	Age, UK/Rol-born and 2 socio-economic variables
WOMEN							
White Scottish	5870	7295	80466.1	100	100	100	100
Other White British	365	450	78820.6	98 (94.6, 101.4)	97.7 (94.3, 101.2)	97.4 (94.1, 100.9)	97.2 (93.9, 100.7)
White Irish	60	80	81980.5	102 (95.2, 109.2)	101.7 (95, 108.9)	102.5 (95.7, 109.7)	102.2 (95.5, 109.5)
Other White	60	85	75242.4	93.3 (84.7, 102.8)	89.7 (80.2, 100.4)	92.6 (84.1, 102)	89.3 (79.8, 99.9)
Any Mixed Background	10	10	77517.8	97.1 (74.6, 126.2)	95.6 (73.7, 124.1)	99 (76.3, 128.5)	97.6 (75.4, 126.4)
Indian	10	10	70873.4	87.9 (64.6, 119.6)	82.7 (60.3, 113.3)	86.6 (64.1, 116.9)	81.7 (60, 111.2)
Pakistani	10	15	88591.8	109.8 (108.2, 111.4)	103.3 (96.3, 110.8)	109.7 (107.3, 112.2)	103.5 (96.3, 111.3)
Other South Asian	.	.					
African origin	.	10					
Chinese	15	25	78820.6	93.3 (77.5, 112.3)	87.7 (72, 106.9)	92.3 (76.6, 111.2)	87.1 (71.4, 106.2)

Supplementary Materials Tables for Campbell et al Are there ethnic and religious variations in uptake of bowel cancer screening in Scotland?

Supplementary Material Table 6C. Colonoscopy performed (Round 2) by ethnic group in men: age adjusted rates and risk ratios (RRs). Results exclude Grampian health board. RRs are adjusted for age, UK/Rol-born (versus born outside UK/Rol) and socio-economic status (household tenure and combined individual and household level education) with 95% confidence intervals (CIs).

RRs (95% CIs): adjustment							
Ethnic group	Colonoscopy performed	Positive screen test results	Rates/ 100,000	Age	Age and UK/Rol-born	Age and 2 socio-economic variables	Age, UK/Rol-born and 2 socio-economic variables
MEN							
White Scottish	7935	9505	83482.4	100	100	100	100
Other White British	505	595	82759.7	99.3 (96.7, 101.9)	99.3 (96.7, 101.9)	98.8 (96.2, 101.5)	98.8 (96.2, 101.5)
White Irish	115	140	84825.9	101.7 (97.1, 106.5)	101.7 (97.1, 106.5)	102 (97.4, 106.9)	102 (97.4, 106.9)
Other White	85	95	84584.3	100.9 (95.5, 106.7)	101.3 (95.2, 107.7)	100.7 (95.1, 106.5)	101.4 (95.2, 108)
Any Mixed Background	10	10	90626	108.4 (107.4, 109.5)	108.6 (107.1, 110.1)	108.8 (107.2, 110.5)	109.1 (107.1, 111.1)
Indian	15	15	84961.9	101.3 (89.3, 115)	101.8 (89.3, 116.1)	101.1 (89.6, 114.1)	102.2 (90, 116)
Pakistani	20	25	78805.2	93.8 (80, 110.1)	94.3 (80.1, 110.9)	93.3 (79.5, 109.6)	94.3 (80.1, 111)
Other South Asian	10	10	90626	108.1 (107, 109.1)	108.6 (103.5, 113.9)	107.9 (105.9, 109.9)	109.1 (103.7, 114.6)
African origin	10	10	90626	107.4 (106.4, 108.5)	107.8 (103.7, 112.2)	107.8 (105.5, 110.2)	108.8 (104.1, 113.6)
Chinese	25	25	90626	108.3 (107.5, 109.2)	108.9 (103.6, 114.5)	108.6 (107.3, 109.9)	109.9 (104.4, 115.6)

Supplementary Materials Tables for Campbell et al Are there ethnic and religious variations in uptake of bowel cancer screening in Scotland?

Supplementary Material Table 6D. Colonoscopy performed (Round 2) by ethnic group in women: age adjusted rates and risk ratios (RRs). Results exclude Grampian health board. RRs are adjusted for age, UK/Rol-born (versus born outside UK/Rol) and socio-economic status (household tenure and combined individual and household level education) with 95% confidence intervals (CIs).

RRs (95% CIs): adjustment							
Ethnic group	Colonoscopy performed	Positive screen test results	Rates/ 100,000	Age	Age and UK/Rol-born	Age and 2 socio-economic variables	Age, UK/Rol-born and 2 socio-economic variables
WOMEN							
White Scottish	6080	7355	82664.9	100	100	100	100
Other White British	365	435	82495	99.8 (96.8, 102.9)	99.9 (96.9, 103)	99.4 (96.4, 102.5)	99.5 (96.5, 102.6)
White Irish	70	85	79995.2	96.9 (89.7, 104.8)	96.9 (89.6, 104.8)	96.8 (89.5, 104.7)	96.8 (89.5, 104.7)
Other White	55	65	84093.3	101.8 (95.2, 108.8)	104 (94.9, 114)	101.9 (95.3, 109)	104.3 (95.2, 114.1)
Any Mixed Background	10	10	89994.6	109.1 (107.8, 110.3)	110.1 (106.7, 113.5)	109.2 (107.9, 110.6)	110.3 (106.9, 113.8)
Indian	10	10	89994.6	107.6 (106.4, 108.8)	110.1 (102.7, 118.2)	107.1 (105.4, 108.8)	109.7 (102.2, 117.8)
Pakistani	15	20	64996.1	78.1 (58.6, 104.1)	80.6 (59.6, 108.9)	78.1 (58.7, 103.9)	80.6 (59.7, 108.9)
Other South Asian	.	.					
African origin	.	10					
Chinese	20	20	85258	102.6 (92.2, 114.1)	105.6 (92.1, 121.1)	101.8 (91.5, 113.3)	105 (91.6, 120.4)

Supplementary Materials Tables for Campbell et al Are there ethnic and religious variations in uptake of bowel cancer screening in Scotland?

Supplementary Material Table 7A. Pathology detected (polyps, adenomas, cancers) (Rounds 1 & 2) by ethnic group in men: age adjusted rates and risk ratios (RRs). Results exclude Grampian health board. RRs are adjusted for age, UK/RoI-born (versus born outside UK/RoI) and socio-economic status (household tenure and combined individual and household level education) with 95% confidence intervals (CIs).

RRs (95% CIs): adjustment							
Ethnic group	Pathology detected	Positive screen test results	Rates/ 100,000	Age	Age and UK/RoI-born	Age and 2 socio-economic variables	Age, UK/RoI-born and 2 socio-economic variables
MEN							
White Scottish	10140	19630	51655.6	100	100	100	100
Other White British	615	1190	51922	100 (94.4, 105.8)	99.9 (94.4, 105.8)	97 (91.6, 102.7)	97 (91.5, 102.7)
White Irish	140	265	52073.3	100 (89, 112.4)	100 (89.1, 112.4)	100.9 (89.9, 113.3)	100.9 (89.9, 113.3)
Other White	95	190	50291.3	98.3 (85.3, 113.3)	96.8 (82, 114.3)	96.4 (83.7, 111.1)	96.2 (81.6, 113.4)
Any Mixed Background	10	15	46756.9	90.3 (56.4, 144.6)	89.7 (55.8, 144.1)	91 (57, 145.1)	90.9 (56.9, 145.2)
Indian	15	30	48832.3	95.6 (65.8, 139.1)	93.4 (63, 138.7)	93.3 (64.2, 135.5)	93 (62.7, 138)
Pakistani	15	45	32456.4	64.5 (42.5, 97.7)	63 (40.8, 97.4)	64.2 (42.5, 97)	64.1 (41.6, 98.6)
Other South Asian	10	20	36533	73.1 (40.7, 131.3)	71.6 (39.3, 130.4)	71.2 (39.5, 128.1)	71 (38.9, 129.6)
African origin	10	15	49766.5	99.1 (60.7, 162.1)	97.4 (59, 160.9)	98.4 (60.4, 160.4)	98.2 (59.7, 161.6)
Chinese	25	55	43452	84.5 (62.5, 114.3)	82.5 (59.5, 114.4)	85.5 (63.2, 115.8)	85.3 (61.4, 118.5)

Supplementary Materials Tables for Campbell et al Are there ethnic and religious variations in uptake of bowel cancer screening in Scotland?

Supplementary Material Table 7B. Pathology detected (polyps, adenomas, cancers) (Rounds 1 & 2) by ethnic group in women: age adjusted rates and risk ratios (RRs). Results exclude Grampian health board. RRs are adjusted for age, UK/Rol-born (versus born outside UK/Rol) and socio-economic status (household tenure and combined individual and household level education) with 95% confidence intervals (CIs).

RRs (95% CIs): adjustment							
Ethnic group	Pathology detected	Positive screen test results	Rates	Age/ 100,000	Age and UK/Rol-born	Age and 2 socio-economic variables	Age, UK/Rol-born and 2 socio-economic variables
WOMEN							
White Scottish	5275	14650	36006.8	100	100	100	100
Other White British	340	880	38451.2	107 (98.2, 116.7)	107 (98.1, 116.7)	103.4 (94.8, 112.8)	103.4 (94.8, 112.9)
White Irish	70	165	40946.5	111.9 (93, 134.5)	111.8 (93, 134.5)	111.9 (93.2, 134.4)	111.9 (93.2, 134.4)
Other White	50	150	32755.6	92.2 (73.3, 115.8)	91.5 (69.9, 119.7)	89.9 (71.6, 112.9)	90.2 (69.1, 117.9)
Any Mixed Background	10	20	30072.4	85 (44, 164.2)	84.7 (43.8, 163.9)	86.4 (44, 169.9)	86.6 (44, 170.4)
Indian	10	20	41942.6	126.4 (74.2, 215.1)	125.1 (71.4, 219.2)	124 (73, 210.3)	124.6 (71.3, 217.7)
Pakistani	.	35					
Other South Asian	.	.					
African origin	.	10					
Chinese	15	45	28605.7	83.9 (52.9, 132.9)	82.9 (50.1, 137.4)	82.3 (52, 130.5)	82.8 (50.1, 137)